spheres of pressure, stands nearly midway between the gas and the liquid; and we have no valid grounds for assigning it to the one form of matter any more than to the other. The same observation would apply with even greater force to the state in which carbonic acid exists at higher temperatures and under greater pressures than those just mentioned. In the original experiment of Cagniard de la Tour, that distinguished physicist inferred that the liquid had disappeared, and had changed into a gas. A slight modification of the conditions of his experiment would have led him to the opposite conclusion, that what had been before a gas was changed into a liquid. These conditions are, in short, the intermediate states which matter assumes in passing, without sudden change of volume, or abrupt evolution of heat, from the ordinary liquid to the ordinary gaseous state.

"In the foregoing observations I have avoided all reference to the molecular forces brought into play in these experiments. The resistance of liquids and gases to external pressure tending to produce a diminution of volume proves the existence of an internal force of an expansive or resisting character. On the other hand, the sudden diminution of volume, without the application of additional pressure externally, which occurs when a gas is compressed, at any temperature below the critical point, to the volume at which liquefaction begins, can scarcely be explained without assuming that a molecular force of great attractive power comes here into operation, and overcomes the resistance to diminution of volume, which commonly requires the application of external force. When the passage from the gaseous to the liquid state is effected by the continuous process described in the foregoing pages, these molecular forces are so modified as to be unable at any stage of the process to overcome alone the resistance of the fluid to change of volume.

"The properties described in this communication, as exhibited by carbonic acid, are not peculiar to it, but are generally true of all bodies which can be obtained as gases and liquids. Nitrous oxide, hydrochloric acid, ammonia, sulphuric ether, and sulphuret of carbon, all exhibited, at fixed pressures and temperatures, critical points, and rapid changes of volume with flickering movements, when the temperature or pressure was changed in the neighbourhood of those points. The critical points of some of these bodies were above 100°; and in order to make the observations, it was necessary to bend the capillary tube before the commencement of the experiment, and to heat it in a bath of paraffin or oil of vitriol.

"The distinction between a gas and vapour has hitherto been founded on principles which are altogether arbitrary. Ether in the state of gas is called a vapour, while sulphurous acid in the same state is called a gas, yet they are both vapours, the one derived from a liquid boiling at 35°, the other from a liquid boiling at – 10°. The distinction is thus determined by the trivial condition of the boiling-point of the liquid, under the ordinary pressure of the atmosphere, being higher or lower than the ordinary temperature of the atmosphere. Such a distinction may have some advantages for practical reference, but it has no scientific value. The critical point of temperature affords a criterion for distinguishing a vapour from a gas, if it be considered important to maintain the distinction at all. Many of the properties of vapours depend on the gas and liquid being present in contact with one another; and this, we have seen, can only occur at temperatures below the critical point. We may accordingly define a vapour to be a gas at any temperature under its critical point. According to this definition, a vapour may, by pressure alone, be changed into a liquid, and may therefore exist in presence of its own liquid; while a gas cannot be liquefied by pressure, that is, so changed by pressure as to become a visible liquid distinguished by a surface of demarcation from the gas. If this definition be accepted, carbonic acid will be a vapour below 31°, a gas above that temperature; ether, a vapour below 200°, a gas above that temperature.

"We have seen that the gaseous and liquid states are only distant stages of the same condition of matter, and are capable of passing into one another by a process of continuous change. A problem of far greater difficulty yet remains to be solved, the possible continuity of the liquid and solid states of matter. But this must be a subject for future investigation; and for the present I will not venture to go beyond the conclusion I have already drawn from direct experiment, that the gaseous and liquid forms of matter may be transformed into one another by a series of continuous and unbroken changes."

JAMES THOMSON

NOTES

AT last a sum of money has been voted for a new Natural History Museum. In introducing the vote the Chancellor of the Exchequer said the British Museum had long been suffering from repletion, and there were no means of exhibiting the valuable articles which, from time to time, were bought for the national collection. Five years ago the trustees resolved in favour of separating the collections, and it had been determined to separate the natural history department from the books and antiquities. For the natural history collection the typical mode of exhibition had been decided on, and the building required must cover at least four acres. Even the present collection would pretty well fill a building of these dimensions, and provision must be made for further extension. The question was, where should this building be situated? and after referring to possible sites he referred to the locality which we were enabled to state some time ago had been chosen—a plot of ground 16½ acres in extent, which the trustees of the Exhibition of 1851 sold to the Government at 7,000*l.* an acre. It therefore cost 120,000*l.*, but is now worth 100,000*l.* more. The sale was coupled with the condition that any building erected upon the land must be for purposes of science and art. For seven years the land had remained waste, a sort of Potter's field, and a scandal to that part of the metropolis. The Government now proposed to place on that piece of land the museum required for the natural history collection. It would occupy four acres; there would be room for wings, and the outside estimate for the building was 350,000*l.*, not an unreasonable price, considering its extent. For the present, however, the Government merely asked for a small vote to enable them to clear the ground, and in order to take the opinion of the House. Railway communication had now made South Kensington easily accessible, and unless a more eligible, a more accessible, and a cheaper site could be suggested, he hoped the Committee would agree to the proposal. He might add that, if it were hereafter thought desirable to do so, there would be room enough on the same site for the Patent Museum, the necessity of which had been much insisted on. We trust that after the discussion which followed the introduction of the vote the scientific men will speak for themselves, and again let their wishes and opinions be heard.

THE American Association for the Advancement of Science met yesterday (Wednesday) at Troy. Professor W. Chauvenet is president for the year.

IT is gratifying to learn that some of the recommendations of the Royal Commission on Military Education, which were most inimical to the scientific instruction of the army, will not be carried out.

BY Imperial decree the *Association Scientifique de France* has been acknowledged to be an *établissement d'utilité publique.*

THE French observers are making preparations for a combined attack on the 10th of August meteors.

THE list of pensions granted during the year ended the 20th of June, 1870, and charged upon the civil list (presented pursuant to Act 1 Victoria, cap. 2, sec. 6) has been published this week. Among them we note the following:—Mr. Augustus De Morgan, 100*l.*, in consideration of his distinguished merits as a mathematician; Mrs. Charlotte J. Thompson, 40*l.*, in consideration of the labours of her late husband, Mr. Thurston Thompson, as Official Photographer to the Science and Art Department, and of his personal services to the late Princ Consort; Dame Henrietta Grace Baden Powell, 150*l.*, in consideration of the valuable services to science rendered by her husband during the 33 years he held the Savilian Professorship of Geometry and Astronomy at Oxford; Miss Margaret Catherine Ffennell, Miss Elizabeth Mark Ffennell, and Mrs.

Charlotte Carlisle, formerly Ffennell, wife of Captain Thomas Carlisle, jointly, and to the survivors or survivor of them, 30*l*.; Miss Margaret Catherine Ffennell, 10*l*.; Miss Elizabeth Mark Ffennell, 10*l*.; Mrs. Charlotte Carlisle, 10*l*., in recognition of the labours of their father in connection with the salmon fisheries of the United Kingdom; Mrs. Jane Dargan, 100*l*., in recognition of the services of her late husband, Mr. William Dargan, in connection with the Dublin Exhibition of 1853, and other works of public importance in Ireland; Mrs. Charlotte Christiana Sturt, 80*l*., in consideration of the services rendered by her late husband, Captain Charles Sturt, by his geographical researches in Australia; William Henry Emmanuel Bleek, Doctor of Philosophy, 150*l*., in recognition of his literary services, and in aid of his labours in the department of philology, especially in the study of the South African languages.

The Radcliffe Observer, the Rev. R. Main, has recently presented his annual report to the Board of Trustees. It concludes as follows:—"An unusually large number of meridional observations have been made, and their reductions kept up to their usual stage; a Second Radcliffe Catalogue of Stars (a work of very considerable labour in its compilation) has been printed and published, in addition to a new ordinary annual volume of the Radcliffe Observations; and, notwithstanding the amount of work of an unusual character which has been performed, none of the ordinary details, either of scientific or of clerk-like work, have in any sensible degree fallen behind or been neglected. I confess that I am well satisfied with what has been accomplished (all of it, in my judgment, being of great utility), and altogether it affords a good specimen of what can be accomplished by a small staff of astronomers well skilled in the making and reducing of observations, and devoting themselves steadily and without intermission to the carrying out of a certain number of definite aims on a plan well prepared and studied beforehand."

Mr. John Hilton, F.R.S., late President of the Royal College of Surgeons, who for twenty years has filled the office of surgeon to the above institution, has just been unanimously elected by the governors Consulting Surgeon—an honour which, adds the *Medical Times*, has not been bestowed on any member of the surgical staff since Sir Astley Cooper.

A committee has begun operations at the Society of Arts for inquiring into the relations of inventors with the Government departments, and the treatment by these latter of scientific inventions. Considerable zeal is shown on the subject, and the whole question of scientific tribunals will be made matter of discussion. Printed forms for collecting the opinions of those interested will be extensively circulated.

The Statistical Society has entered on a new epoch of activity. Formerly its presidents were statesmen, but it determined lately, like other learned Societies, to select its president from among its own working members, by choosing Mr. Newmarch, F.R.S. This has been attended with more vigorous action of the Council, and corresponding interest among the Fellows. For the first time the Society, the resources of which have always been limited, gives a premium, having received a donation of fifty guineas from Mr. Wm. Taylor, a Fellow. The Taylor premium is to be devoted to an essay on the subject of Taxation in England, and it appears likely that it will be the means of bringing out many new points on an old and trite subject.

In order to encourage science our authorities have accorded to graduates of the Lahore University the envied privilege of being seated in Durbar and on other state occasions.

The first of the Quarterly Weather Reports of the Meteorological Office, with pressure and temperature tables for the year 1869, and notes on Easterly Storms, issued by the Meteorological Committee, embodies the results of observations made at the observatories of Kew, Stonyhurst, Glasgow, Aberdeen, Armagh, Falmouth, and Valencia, during the first three months of last year. The succeeding quarterly numbers for the year will follow as quickly as possible, and the journal will in future appear regularly at intervals of three months. The first number contains complete tables for pressure and temperature, &c., for the year 1869, and the plates exhibiting the continuous registration of these observations for the quarter are arranged to show at one view the instrumental curves at each of the stations for five days, one plate comprising pressure and temperature, while another shows the direction and velocity of the wind, scales of measurement being given at the sides both on the British and French systems. We shall return to this report.

The *Engineer* states that the new dye known as soluble garnet seems to be coming more largely into use on the Continent, and as the colours produced with it are exceedingly brilliant, similar to those obtained with archil, but much more stable when exposed to light and air, the garnet dye is likely to become a great favourite. The dye was first prepared by Casthelaz of Paris, and is the ammonia salt of isopurpuric acid, which is formed by the action of a metallic cyanide upon picric acid. It is not prepared from the pure crystallised, but from an inferior kind of picric acid, and is probably destined to replace the archil in many cases, in imparting to wool all shades from garnet to chestnut brown. It may be readily combined with other pigments, so that a number of different colours may be obtained. According to Casthelaz, the dyeing of wool and of silk is effected by the addition of an organic acid to the bath, for instance, acetic or tartaric acid, mineral acids being excluded. The dye bath for silk should be cold or tepid in the beginning. Different shades in red and brown are thus obtained that are dependent upon the concentration of the bath, the nature of the mordant, and the time of the operation.

In the attempts now being made further to utilise the hill regions of India for English residence, the Observatory at Nynee Tal, itself a hill town, is to be removed to Raneekhet, which is said to be chosen by some of its patrons as the future hill capital of India.

A horticultural establishment has been opened at Guatemala for the export of the seeds, flowers, and young plants of the country.

The Peruvian Government is endeavouring to develop the saltpetre district of Tarapaca.

A rich silver mine has been discovered by Messrs. Lepiani and Steffani near Huamantanga, in Peru, and measures are taken for working it.

The field of the new silver mines near Cobija, in Bolivia, the discovery of which was reported by us, is stated to be 3,000 to 5,000 marcs per cajou, or from 700*l*. to 1,200*l*. of silver per ton of ore.

On the 16th June an earthquake was felt all over the state of Nicaragua. At Granada, alarming noises were heard from Momotombo, an extinct volcano in the neighbourhood.

On the 26th May there was a tremendous earthquake at Lima, the first for a long time. It was also felt at Callao.

Among the sums voted last week by the House of Commons in Committee of Supply were the following:—64,721*l*. for Public Education in Great Britain; 164,836*l*. to complete the vote for the Department of Science and Art (being an increase of 11,883*l*. on the vote of last year); 51,255*l*. to complete the vote for the Museum; 6,827*l*. for the University of London; 8,220*l*. for the salaries and expenses of the Endowed Schools Commission; 12,894*l*. for the Scottish Universities; 2,140*l*. for the Queen's University, Ireland; and 2,915*l.* for the Queen's Colleges, Ireland. The total educational estimate for the year was stated by Mr. Forster to be 914,721*l.*, being a net increase of 74,010*l.* over that of last year. The day scholars in average attendance have increased from 1,082,000 to 1,200,000. There are 223 more male and 104 more female teachers than last year. Since 1868 the number of Science schools has increased from 300 to 810, and the number of scholars is now nearly 30,000; the number of scholars in Art has increased since last year from 123,562 to 157,198. The increase in the number of scholars in the regular schools is stated to be in excess of the increase of population. These statistics are interesting, as showing that the increased desire for education in the country at least keeps pace with the advance of opinion among the governing classes in favour of a truly national system of education. The query whether prevention is better than cure is forcibly suggested by three other votes which were passed on the same night:—315,627*l.* for convict establishments in England and the colonies, 203,880*l.* for the maintenance of juvenile prisoners in reformatories, and 643,070*l.* for the constabulary force in Ireland. When shall we arrive at the pitch of civilisation of one of the Swiss Cantons, where the expenditure for educational purposes exceeds that for all other purposes put together?

WE learn from the last report of the Geological Survey of Italy (R. Comitato Geologico) that that body will publish a geological map of Italy on the scale of 1 to 600,000 during the course of next year. The map is that which was compiled by Professor I. Cocchi in 1867 and sent to the Universal Exhibition in Paris. It was a hand-coloured map, the Ordnance map of Upper and Central Italy in six sheets being used as a basis. In compiling this map Professor Cocchi made use of all the published and unpublished materials that he could find. The most southern provinces of the Peninsula and Sicily were not however represented, for although notes and papers on their geology were not wanting, that part of the kingdom had not been mapped geologically. The new map will be divided into four sheets, and new plates will be engraved copying the topography of the Ordnance map, and introducing such modifications and improvements as may be deemed necessary for the new object to which the map is to be applied. The colouring will be done by chromolithography. Accompanying the map there will be a short descriptive memoir and two geological sections, one along the length and the other across the breadth of the country.

M. DIAMILLA-MULLER calls upon all directors of magnetical observatories to observe the declination and inclination every ten minutes from midnight 29th of August (Paris time), to the next midnight, and send the results to him at the bureaux of the Association Scientifique de France. He adds, "On croyait généralement que le soleil agissait indirectement par suite des changements de température qu'il produit à la surface de la terre. J'avais déjà présenté l'hypothèse, basée sur les observations d'Arago, tendant à établir que l'action directe du soleil sur le magnétisme est absolument semblable à l'action d'un aimant sur le fer. Cette théorie est confirmée par les observations faites dans les Colonies anglaises, où l'on remarque l'opposition de signe que le changement de déclinaison du soleil imprime aux courbes qui représentent la variation magnétique dans les pays tropicaux. Il est nécessaire de constater, par une observation directe, que cette loi d'opposition, en rapport avec la déclinaison solaire, s'exerce dans toutes les régions du globe."

PROF. LIONEL BEALE's inaugural lecture to the course of Pathological Anatomy, delivered at King's College, May 5th, 1870, is issued as a separate publication, with the title "On Medical Progress; in memoriam R. B. Todd."

THE third part is published of Dr. Manzoni's "Bryozoi fossili Italiani," accompanied by four plates.

ANOTHER contribution to astronomical literature lies on our table, in the shape of the second volume of "Astronomical Observations taken during the years 1865-69, at the private Observatory of Mr. J. G. Barclay, of Leyton."

MR. KEITH JOHNSTON, jun., publishes, in his usual admirably clear style, a map of the Lake Region of Eastern Africa, showing the sources of the Nile, recently discovered by Dr. Livingstone; with notes on the exploration of this region, its physical features, climate, and population.

ON VOLCANOES[*]

VOLCANOES are but so many existing proofs of the activity of internal forces at the present moment, and, as a geologist, I may be almost pardoned if I regret that we do not in our happy isles possess even a single example of an active volcano.

As regards the geographical distribution of recent volcanoes, a glance at the geological map of the world will suffice to show that they are in reality scattered all over its surface, yet, it may be added, more rarely occurring at any great distance from the sea, although exceptional instances are met with inland, in all the four quarters of the globe.

In the North we find the volcanoes of Iceland, Jan Meyen, Kamskatca, Alaska, and others; whilst the Antarctic voyages of Ross proved that the mountains of the land nearest accessible to the South Pole were also active volcanoes.

At the equator, all but innumerable volcanoes are seen in the islands of the Indian and Polynesian Archipelagos, as well as in the Pacific and Atlantic Oceans, and on the main land of South America. Midway between the Equator and the Poles are situated the volcanoes of New Zealand, the Canaries, Cape Verde, Azores, and Sandwich Islands, as also those of Arabia, Eastern Africa, Mexico, Central America, and the volcanoes of the whole range of the Andes down to Terra del Fuego. Nearer home, Vesuvius, Etna, Stromboli, Santorin, and numerous others in the Mediterranean, if not so grand in their dimensions as some of those previously referred to, still present on the large scale all the various aspects of volcanic phenomena, both submarine as well as terrestrial.

If now, however, we take a broader view of volcanic phenomena, and, in addition to the before-mentioned still existing proofs of the general distribution of volcanic centres, as they have been termed, we also take into consideration the occurrence of eruptive rocks of similar origin which are everywhere found disturbing and breaking through the strata of even the oldest rock formations, it will be seen, as least as far as the geology of the earth's surface is at present known to us, that there is scarcely a single area of any magnitude, of either the land or sea, which, at some period or other, has not been broken through or disturbed by what may be termed volcanic forces acting from within the mass of the earth itself; and it is impossible to come to other than the conclusion that these agencies must have played a most important part in determining the main features of the earth's external configuration as well in our times as throughout all periods of its history.

If now the question be asked, what is a volcano? the simplest reply would be "a hole in the ground deep enough to reach such portions of the interior of the earth as are in a molten condition."

In ordinary language, however, the appellation of volcano is usually restricted to those cone-shaped mountains, from the hollow summit of which flames, smoke, and vapours are at times seen to ascend, and which occasionally break out into more imposing activity by vomiting forth showers of ashes and fragments of incandescent rock, or by pouring out torrents of molten stone, to deluge and devastate the unfortunate country in the vicinity.

It having always been admitted that volcanoes owed their origin to forces operating from below, it was suggested by Von Buch, and supported by Humboldt and others, that volcanic cones must be formed by some portion of the surface of the earth, weaker than the rest, being forced out, or, as it were, thrown up like a soap-bubble by the pressure of the vapour and gases confined below, the strata being thereby elevated, fractured, and tilted up on all sides, so as to produce a conical elevation, the central fissure in which became a crater or vent for the escape and passage of the gaseous and liquid emanations from below.

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[*] Outline of a Lecture delivered at St. George's Hall, Langham Place, 9th June, 1870, by David Forbes, F.R.S.